Puget Sound Acquistion & Restoration Fund

Puget Sound Recovery Projects
Application Project Summary

TITLE: Oak Bay Park Sand Lance Habitat Restoration	**NUMBER:** 09-1659P (Planning/Acquisition) **STATUS:** Preapplication
APPLICANT: Jefferson County MRC	**CONTACT:** Gabrielle LaRoche (360) 531-2458

COSTS:

RCO	$119,745	100 %
Local	$0	0 %
Total	$119,745	100 %

SPONSOR MATCH:

DESCRIPTION:

The project is in the mainland part of Jefferson County Oak Bay Park, west of the Port Townsend Ship Canal in northwest Oak Bay. The site is comprised of a spit, salt marsh and open-water tidal lagoon, nearby eelgrass, and a documented sand lance spawning beach. Immediately south is Little Goose Ck., a coho salmon and resident cutthroat stream. This critical nearshore habitat is impacted by an armored rock revetment and derelict boat ramp. As this is the only refugia for out-migrating salmon before traversing the armored ship canal into Port Townsend Bay, removal of the rock revetment and boat ramp will benefit salmon by improving nearshore habitat conditions for out-migrating salmon and salmon prey.

The goal of the Oak Bay Park Sand Lance Spawning Habitat Restoration Project is to restore documented sand lance spawning habitat and improve nearshore marine habitat for salmon and salmon prey by removing the armoring and boat ramp. Potential restoration feasibility was conducted for Oak Bay Park in 2007 and detailed restoration feasibility and conceptual design was conducted this spring. SRFB support for Phase 1 (*Design & Permitting*) will complete final beach restoration and possible inlet relocation design, biological assessments, project permitting and pre-implementation planning. Phase 2 (*Implementation*) will rehabilitate sand lance habitat; restore marine riparian vegetation; and restore drift cell function to 1,110 lineal feet of nearshore habitat. This request is for Phase 1.

LOCATION INFORMATION:

COUNTY:

GOAL & OBJECTIVE:

The goal of the project is to protect and increase/improve information to help select projects that have a high certainty and benefit.

The objective of the project is to protect and determine feasibility of creating or reconnecting off-channel habitat.

PERMITS ANTICIPATED:

Dredge/Fill Permit [Section 10/404 or 404]
Hydraulics Project Approval [HPA]
Shoreline Permit
Water Quality Certification [Section 401]

SALMON INFORMATION: (* indicates primary)

Species Targeted

Coho*
Cutthroat

Habitat Factors Addressed

Biological Processes
Estuarine and Nearshore Habitat*
Loss of Access to Spawning and Rearing Habitat

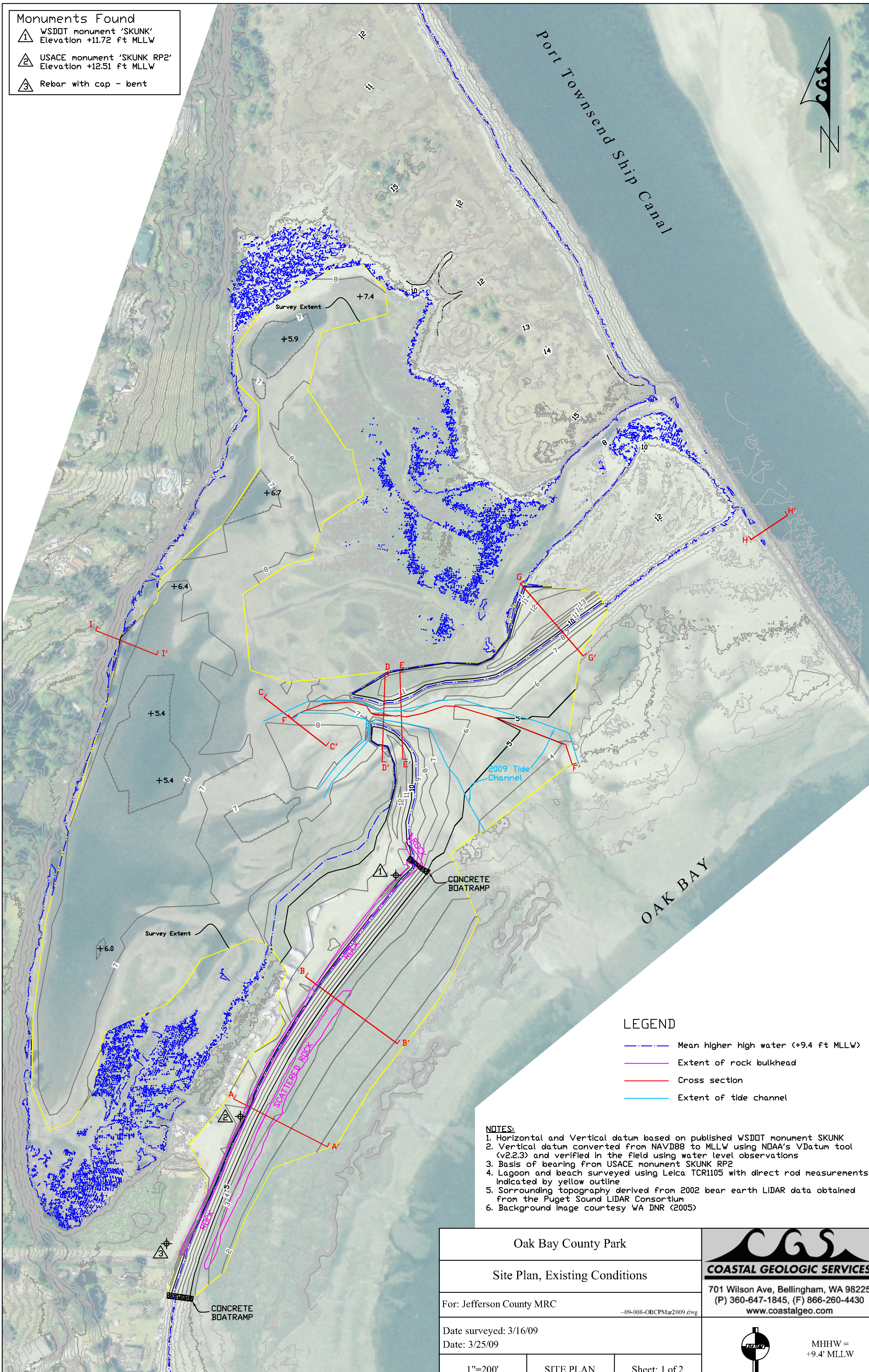
LAST UPDATED: June 19, 2009	**DATE PRINTED:** June 25, 2009

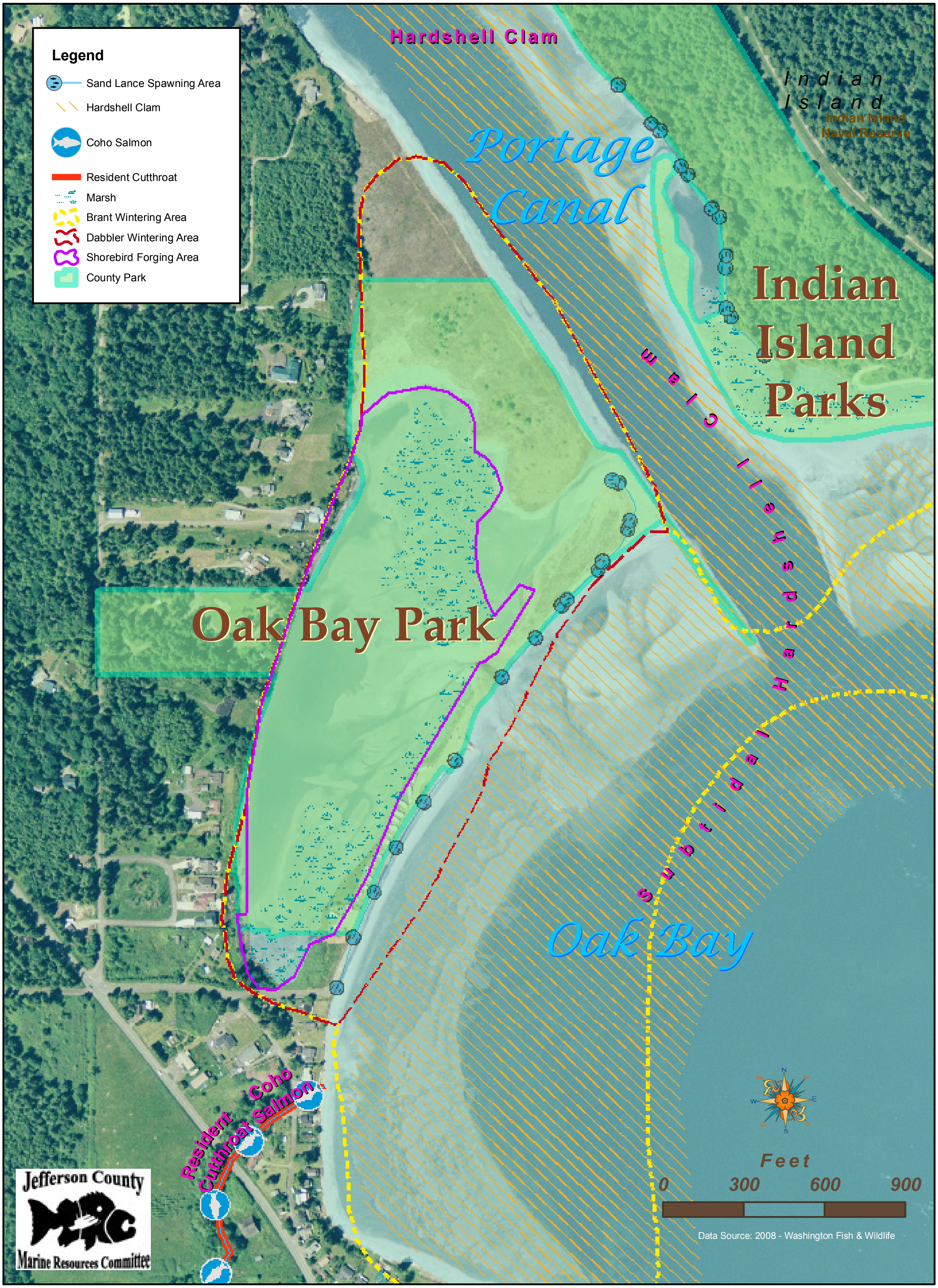
Planning Cost Estimate Summary

Jefferson County MRC **09-1659 P**

Oak Bay Park Sand Lance Habitat Restoration **Puget Sound Acq. & Restoration**

Element/Item	Unit	Quantity	Unit Cost	Total Cost	Description Needed	Description
Worksite #1, Oak Bay County Park (Mainland)						
Communications						
Postage	Lump sum		$150.00	$150.00	Optional	
Printing, binding, copying	Lump sum		$200.00	$200.00	Optional	
Professional Services						
Consultant(s)	Lump sum		$16,000.00	$16,000.00	Optional	project management, permitting & coordination w/parks, Tribe
Consultant(s)	Lump sum		$98,196.00	$98,196.00	Optional	reference site analysis, hydrodynamic modeling, design, etc.
Consultant(s)	Lump sum		$2,000.00	$2,000.00	Optional	biological assessment (beach and inlet seines)
Salaries & Benefits						
Salaries & Benefits - other	# of FTE's		$2,500.00	$2,500.00	Title	fiscal reporting (WSU)
Supplies						
General supplies	Lump sum		$300.00	$300.00	Optional	
Transportation/Travel						
Transportation/travel - other	Lump sum		$399.00	$399.00	Describe	
Project Tax Amount				$0.00		
Project A&E Amount				$0.00		
Project Total Costs				**$119,745.00**		


Monuments Found
1 WSDOT monument 'SKUNK' Elevation +11.72 ft MLLW
2 USACE monument 'SKUNK RP2' Elevation +12.51 ft MLLW
3 Rebar with cap - bent
Port Townsend Ship Canal
OAK BAY
Survey Extent
Survey Extent
+7.4
+5.9
+6.7
+6.4
+5.4
+5.4
+6.0
2009 Tide Channel
CONCRETE BOATRAMP
CONCRETE BOATRAMP
ROCK
SCATTERED ROCK
ROCK
ROCK
LEGEND
Mean higher high water (+9.4 ft MLLW)
Extent of rock bulkhead
Cross section
Extent of tide channel
NOTES:
1. Horizontal and Vertical datum based on published WSDOT monument SKUNK
2. Vertical datum converted from NAVD88 to MLLW using NOAA's VDatum tool (v2.2.3) and verified in the field using water level observations
3. Basis of bearing from USACE monument SKUNK RP2
4. Lagoon and beach surveyed using Leica TCR1105 with direct rod measurements, indicated by yellow outline
5. Surrounding topography derived from 2002 bear earth LiDAR data obtained from the Puget Sound LiDAR Consortium
6. Background image courtesy WA DNR (2005)
Oak Bay County Park
Site Plan, Existing Conditions
For: Jefferson County MRC
~09-008-OBCPMar2009.dwg
Date surveyed: 3/16/09
Date: 3/25/09
1"=200'
SITE PLAN
Sheet: 1 of 2
COASTAL GEOLOGIC SERVICES
701 Wilson Ave, Bellingham, WA 98225
(P) 360-647-1845, (F) 866-260-4430
www.coastalgeo.com
MHHW = +9.4' MLLW
MLLW=0.0'


Legend
Sand Lance Spawning Area
Hardshell Clam
Coho Salmon
Resident Cutthroat
Marsh
Brant Wintering Area
Dabbler Wintering Area
Shorebird Forging Area
County Park
Hardshell Clam
Portage Canal
Indian Island
Indian Island Naval Reserve
Indian Island Parks
Oak Bay Park
Hardshell Clam
Subtidal Hardshell Clam
Oak Bay
Coho Salmon
Resident Cutthroat
Jefferson County
Marine Resources Committee
Feet
0 300 600 900
Data Source: 2008 - Washington Fish & Wildlife

Jefferson County MRC; Oak Bay Park Sand Lance Habitat Restoration (#09-1659)
Worksite: #1, Oak Bay County Park (Mainland)
05/21/2009, Attachment #8, Oak Bay County Park - looking north

Jefferson County MRC; Oak Bay Park Sand Lance Habitat Restoration (#09-1659)
Worksite: #1, Oak Bay County Park (Mainland)

Jefferson County MRC; Oak Bay Park Sand Lance Habitat Restoration (#09-1659)
Worksite: #1, Oak Bay County Park (Mainland)
05/21/2009, Attachment #7, Oak Bay County Park - looking west

Oak Bay County Park
Restoration Feasibility & Design
Jefferson County, WA

Prepared for:
Jefferson County MRC

Prepared by:
Coastal Geologic Services Inc.
Jim Johannessen, MS, Licensed Engineering Geologist
Jonathan Waggoner, BS

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June, 2009

Introduction

Coastal Geologic Services, Inc. (CGS) was contracted to perform a restoration feasibility assessment and conceptual design for the south shore of Oak Bay County Park (the Park) in eastern Jefferson County. The stated vision for the Park is to provide public, non-vehicular access for enjoyment of the beach, salt marsh, and lagoon. Restoration was expected to involve removal of the road, camping sites, and beach armoring. The project aim for CGS was to map potential features to be removed for restoration and study the existing tidal inlet for current stability as well as possible impacts of various restoration alternatives. CGS retained the consulting services of Phillip Williams and Associates, Ltd. (PWA) to assist with inlet stability analysis.

This work builds on a Phase I report by CGS for the Jefferson county MRC that addressed the potential for nearshore/coastal restoration at four sites in eastern Jefferson County, one of which was Oak Bay County Park (Johannessen and Waggoner 2007). The criteria for restoration feasibility used in the 2007 report included the presence of restorable intertidal, upper beach and backshore areas, along with willingness on the part of landowners to participate in the project. Detailed design work was completed for a different site in the 2007 report. The selection of the site for design work was based on landowner cooperation as of 2007 and feasibility based on physical processes and erosion processes and trends. Since 2007, Jefferson County Parks has changed their management approach for the Park.

The stated vision for the Park is to provide public, non-vehicular access for enjoyment of the beach, salt marsh, and lagoon. Restoration would involve removal of the road, camping sites, and beach armoring on the spit, if deemed feasible. The management of the former campground on the spit has required more and more maintenance over time due to erosion of the south beach, settling of the rock revetment, and rising sea levels. This has caused progressive erosion, severe and repeated damage to the road on the spit, and flood and wave damage to the campsites. Currently, the large majority of the campsites on the spit are decommissioned. Complicating the issue is the lagoon inlet, which recently formed in the central portion of the Park beach, and may require maintenance or relocation. An initial assessment of the potential for erosion to the landward side of the lagoon under each of the alternatives discussed here was covered by Johannessen (2009). Due to unanticipated complications on the degree of complexity of the project, the existing budget was not sufficient to get to design drawings beyond the conceptual restoration alternatives. This included unknown issues of the site containing archaeological site(s), tribal concerns with portions of the proposed restoration approaches, poorly documented site history, and the difficulty of working with the Army Corps of Engineers (USACE) regarding the Port Townsend Ship Channel. Also a No-Action scenario and 3 Restoration Alternatives were developed, which exceeded the scope of the project and used a portion of the budget.

Site Analysis

Location and Site Conditions

Oak Bay County Park is located on the western side of the Port Townsend Ship Canal in northwest Oak Bay at the end of Portage Way (Figure 1). The access road runs along the (filled) top of the spit (Figure 2). The waterward edge of the road has been armored with a rock revetment comprised of 2-3 ft rock. Immediately landward of the inactive and active campsites is a salt marsh complex and open-water tidal lagoon (Figure 3).

Site analysis began prior to visiting the Park. Background information review, coastal processes analysis, planning and coordination were carried out prior to physical assessment and mapping. This included reviewing published and available unpublished sources of information on coastal processes, erosion/accretion trends, and issues related to feasibility for habitat enhancement at the site.

The Park consists of the mostly decommissioned spit campsites and a much larger upland campsite and surrounding area on the north shore of the lagoon (Figures 4 and 5). The southern, spit portion of the site sits atop a gravel and sand spit fronting a large saltmarsh and mudflat complex that historically stretched across the entirety of the area immediately north of Oak Bay, prior to dredging of the ship canal between Port Townsend Bay and Oak Bay (Figure 6). The Port Townsend Ship Canal was dredged in approximately 1915 (Todd et al. 2006). Dredge spoils from creation of the approximately 15 ft deep channel (below mean lower low water [MLLW]) were placed on the former mudflat adjacent to the ship canal to make dry land north of the spit (Figures 1 and 6). The channel both breached the spit, which used to be continuous, and severely altered the former mudflat to become an upper intertidal lagoon, dry land, and deepwater channel (Glaster 1989, Todd et al. 2006). Table 23 from Todd et al. (2006) lists the approximate habitat area conversion between 1872 and 2000 (Table 1).

Table 1. Summary of habitat changes to the Little Oak Bay Lagoon habitat complex between 1871 and 2000, after Todd et al. (2006) Appendix B-6 Table 23.

Habitat Type	Area (ha)		Change	
	Historical	Today	Area (ha)	Percent
Spit (area)	5.74	2.14	-3.60	-63
Tidal Marsh	4.05	6.90	+2.85	+70
Lagoon	0	8.72	+8.72	+100
Tidal flat	36.02	0	-36.02	-100
Total (spit,marsh, lagoon)	9.79	17.76	+7.97	+81

The Park and adjacent coasts were visited and examined in detail by Jim Johannessen and Jonathan Waggoner of CGS in March 2009, and also in 2007. Additionally, this author has been observing this site periodically since the late 1990s. Site mapping carried out for the current project included high accuracy topographic and bathymetric surveying, GPS mapping, beach sediment characterization, net shore-drift assessment, and general backshore and saltmarsh vegetation characterization.

Coastal Processes

Net-shore drift refers to the long-term effects of littoral drift on a coastal area. To understand the present dynamics affecting the Park area coast, the larger coastal system from the southern portion of Oak Bay up to the Park must be considered. The basic coastal processes that control the formation and evolution of the spit and lagoon will first be examined, and then the site-specific processes affecting the spit and lagoon will be examined.

Shore drift is the combined effect of longshore drift, the sediment transported along a coast in the nearshore waters, and beach drift, the wave-induced motion of sediment on the beachface in a longitudinal direction. While shore drift may vary in direction seasonally, *net shore-drift* is the long-term, net effect of shore drift occurring over a period of time along a particular coastal sector (Jacobsen and Schwartz 1981). The concept of a drift cell has been employed in coastal studies to represent a sediment transport sector from source to deposition along a coast. A drift cell is defined as consisting of three idealized components: a site (erosional feature or river mouth) that serves as the sediment source and origin of a drift cell; a zone of transport (which usually also contains sediment source bluffs), where wave energy moves sediment alongshore; and an area of deposition that is the terminus of a drift cell (Johannessen and MacLennan 2007). Deposition of sediment occurs where wave energy is no longer sufficient to transport the sediment in the drift cell. Although this model is much simpler than the reality of Puget Sound area coasts, the basic model helps understand the formation and maintenance of the large spit in the Park.

Net shore-drift in the northern Oak Bay area was mapped by Ralph Keuler of the US Geological Survey (Keuler 1988). Mapping of southern Oak Bay was completed by Johannessen (1992) for the WA Dept. of Ecology. These studies were conducted through systematic investigations of the coast of the entire study area to identify geomorphologic and sedimentologic indicators that revealed net shore-drift directions and drift cell extent. The methods employed in net shore-drift mapping utilized well-documented isolated indicators of net shore-drift in a systematic fashion (Jacobson and Schwartz 1981). The net shore-drift cell in this portion of Oak Bay starts approximately 2 miles north of Olele Point, and proceeds north to the western jetty of Port Townsend Ship Canal (Figure 1), located at the northeast end of the Park site (Johannessen 1992).

Recent severe winter storms have caused significant erosion to the waterward side of the spit in the park. The storm that did the most damage occurred on February 4, 2006 (Tyler pers. comm. 2007). Storm waves have overtopped the rock revetment, removing large sections of pavement, and throwing drift logs and gravel onto the road and camping area. Further erosion threatens the recreational use of the park. Additional damage to the road on the spit has occurred in the winter of 2008-09. No erosion was observed on the landward side of the lagoon in the spring 2009 field reconnaissance. Deposition of overwash there was gradually causing the landward migration of the spit, which can also be described as a barrier beach, and is a common and natural occurrence (Zenkovitch 1967). What is not natural about the spit is the presence of the large rock revetment on the south shore. This structure limits the amount of overwash and has therefore contributed to the loss of sediment and size (area) of the spit. Sediment is instead transported alongshore rather than to the landward side of the spit.

Mapping

Historic conditions were examined in a GIS using data from USCGS T-sheet no. 1304 from 1872 (Figure 4) and LiDAR data collected in 2001-02 by the Puget Sound LiDAR Consortium combined with the recent CGS field survey. During the 1872 survey the spit consisted of a continuous shoreline connecting the mainland to Indian Island with a saltmarsh and broad mud flat to the north. While a portage was marked on the map, no channel existed between Oak Bay and Port Townsend Bay at that time. Between 1872 and 2009 very little change has occurred to the landward side of the lagoon, while as much as one-half of the historic spit area has been lost.

The CGS Survey mapped several features identified for removal: The rock shoreline armoring, scattered rock low on the upper beach, boat ramp, road on the south spit, and camping sites. The shoreline armoring, consisting of 2–3 ft angular, stacked rock, covered a total length of 1,110 ft alongshore for a total aerial coverage of 12,100 ft^2. The depth of rock is unknown, as no excavation was made during the site survey, and no as-built plans are known to exist. Many small (12” and less), angular rocks were seen scattered low on the upper beach, partially covering 14,800 ft^2 of intertidal area. These rocks were likely tumbled from the larger rock armoring during high-water storm events. The boat ramp, consisting of mostly broken concrete slab, covered 588 ft^2 of upper beach. Much of the lower section of concrete has been broken up and scattered by wave action. The road and compacted shoulder area immediately landward of the rock covered 35,800 ft^2, while the camp sites covered 32,400 ft^2.

Inlet Stability

The present inlet opened in a storm in December 2003 (Todd et al. 2006, Latham pers. comm..). Prior to that, a very small and intermittently open inlet was present along the west edge of the west jetty (USACE 2003, Latham pers. comm.). With both inlet locations, the result of net shore-drift along the Park shoreline has been the transport of a large quantity of sediment to the inlet, which tends to get transported into the inlet by the prevailing southerly wind waves. The flood tide also tends to bring more sediment into the inlet, which is then deposited on the flood tidal delta, just inside the lagoon. While the subsequent ebb tide does transport some of the sediment back out of the lagoon, the likely net impact of flood and wind wave transport has been infilling of the flood delta.

A more in depth examination of inlet stability was undertaken by PWA as a part of this study (Appendix 1). That analysis used the relationship between potential tidal prism and wave power proposed by Johnson

(1973). The results showed that the existing inlet “is marginally stable and may be subject to periodic closures under existing conditions”. Additionally, PWA reported that the boat ramp acts as a groin, which limits wave-induced sediment transport into the inlet, permitting the inlet to remain open. In full agreement with CGS qualitative analysis, if the rock revetment and boatramp were simply removed, the likely result would be accelerated inlet closure.

Flood Tidal Delta Infilling

LiDAR data from early 2002 obtained from the Puget Sound LiDAR Consortium (LiDAR 2002) was compared with CGS ground survey data from 2009 to help determine the rate of change within the flood tidal delta (FTD) inside the lagoon. The LiDAR was captured at a time when water levels within the lagoon were at approximately +8 ft MLLW, and was unable to penetrate the water surface. An estimate of the water depth was made using the 2009 survey as a guide. A handful of new points were then created for the LiDAR surface at the estimated elevations in an area surrounding the current flood delta, which were limited to the northwest side of the FTD.

A volume change analysis was then performed between the augmented LiDAR surface and the 2009 surveyed surface (Figure 7). The analysis area included the entire 2009 FTD, and excluded the spit berms on either side of the existing channel. Approximately 2,100 cy of sediment had been added to the edges of the FTD as it accreted into the lagoon. Approximately 1,100 cy of sediment was removed from the areas currently occupied by the tidal channel. The inlet was not open at the time of the LiDAR flight, having only been open from December 2003 until present (March 2009 survey date). The net change in volume of the analysis area since December, 2003 was approximately 1,000 cy, an infill rate of 190 cy/yr. The deposition may be closer to the 2,100 cy of fill volume. However, considerable error may be associated with this analysis. The LiDAR data was augmented with assumed water depths. These assumed elevations may carry considerable error through the volume change work, as small changes in elevation produce substantial changes in the volume analysis result. Additionally, the bare-earth LiDAR data may not accurately collect true bare-earth values, but rather a point within the vegetation cover representing the farthest point the laser could penetrate. The level of error in this analysis may exceed 50%. However, a qualitative examination of aerial photography does show considerable change in the size of the flood tidal delta, and therefore lends validity to the above analysis. Ron Hirschi, who has sampled juvenile salmon and other fish in the inlet periodically since 2004, stated that the channel has been filling in in recent years (Hirschi pers. comm. 2009).

Restoration Alternatives

The potential alternatives for the location of the inlet to Little Oak Bay Lagoon currently under consideration in this project are:

- No Action

- Alternative 1: Removal of Revetment and Boatramp
- Alternative 2: Removal and Alternative Inlet Location 1
- Alternative 3: Removal and Alternative Inlet Location 2

No Action

The No Action alternative would be just that, no changes made by man. The inlet would stay open as long as it is stable. However, it may be filling to some extent at present (Hirschi 2009). By definition, there would be no human modification and the present trend of no noticeable erosion on the landward shore of the lagoon would very likely continue. The spit west of the inlet receives a relatively large volume of sediment through net shore-drift from the south (Figure 1; Johannessen 1992), but has also shown a trend of erosion. This erosion, which is a natural spit process of erosion of the beach and overwash of sediment to the landward side of the spit, would continue. What is not functioning at present is the overwash, as the revetment and road mostly prohibit this from occurring. Instead most of the beach sediment appears to be transported alongshore (with some of it going into the inlet). This gradual beach erosion will likely be accelerated by sea level rise and climate change (IPCC 2007, Overpeck 2006).

Based on the stability analysis by PWA (Appendix 1) and qualitative geomorphic analysis by CGS, the No-Action alternative may result in the inlet closing, as the wave energy at the south beach and the volume of net shore-drift sediment may overcome the ability of the tidal prism to maintain the channel. Examining the inlet stability question in a comparative way, lagoons inlets seldom occur on south facing spits with similar fetch in this region. This would result in higher water levels in the lagoon at most times, as compared to present conditions. Inlet closure would also end fish access to the lagoon and salt marsh. This would be a major reduction in overall ecological function of the lagoon, which has been used by juvenile pick and chum salmon during limited sampling (Hirschi 2004). The lack of a functioning inlet was the impetus of the USACE (2003) preliminary analysis. This topic obviously needs additional work. The USACE estimated that overall feasibility work would cost $380,000 (USACE 2003).

The salt marsh and lagoon have been losing area at a moderate rate in the area immediately north and northeast of the present inlet location (Figure 8). Also the accretion of the FTD into the lagoon also decreases the salt marsh area. Both of these processes reduce the tidal prism of the lagoon, reducing its ability to keep the channel open. The No Action alternative would therefore be expected to result in a continuation of these trends and has the lagoon system on a trajectory of gradual infilling and gradually reduced habitat areas, along with an increased tendency for the inlet to close.

Inlet closure would have a slightly greater potential for wind generated waves created in the lagoon to reach the upper beach and bank toe area on the northwest shore. Therefore if the inlet were to close, it may result in slightly more wave induced erosion inside the lagoon, particularly on the northwest and north shores as southerly winds are both predominant and prevailing in the region.

Alternative 1

This alternative involves the complete removal of the shoreline armoring at the park along with the boat ramp. Additionally, the road would be removed and the waterward side of the road area will be regraded to more closely resemble natural beach/spit conditions (Figures 2 and 4). This alternative follows the 'simple structure removal only' approach that was under initial consideration prior to the concern that removal would result in the infilling of the present inlet. Depending on the subsurface conditions beneath the road either sediment excavated from on-site or imported sediment would be used to recreate the upper beachface through to the backshore that more closely resembles pre-development conditions. No changes would be made to the existing inlet (Figure 5). Fill sediment placed to create the former camp sites and picnic table areas would be removed to restore portions of the southern edge of the salt marsh.

Restored areas would include the approximately 12,100 ft^2 of rock cover in the revetment and 14,800 ft^2 of partial rock cover area on the lower beachface waterward of the revetment. The approximately 35,800 ft^2 of road cover and approximately 32,400 ft^2 of the former camp site fill areas along the southern edge of the salt marsh would also be removed. All of these areas (95,100 ft^2 or 2.2 acres) would be restored to resemble natural beach and spit conditions.

If the revetment and boatramp were removed and no other changes were made, the Inlet would likely remain open for some time prior to a fairly likely closure in coming years as net shore-drift would deliver sediment to the inlet throat as well as sediment derived from erosion of the beach just west of the inlet. The reasoning for this conclusion is contained in the discussion of the No Action Alternative above. Inlet closure would be more likely (and could occur sooner) than would be seen in the No Action alternative without the wave refraction and sediment trapping caused by the boat ramp and revetment. Without the boatramp and its affect on wave refraction, a closed inlet is unlikely to reopen and remain open due to wave attack as has happened in the past.

Alternatives 2 & 3

Alternative Inlet locations 1 and 2 are very similar to the conceptual alternatives forwarded by the USACE (2003) in a preliminary report. Both involve the complete removal of shoreline armoring at the park along with the boat ramp. The current tidal inlet would be closed off and a new tidal inlet would be created on the eastern side of the lagoon. The location of the new channel is the only variable between these two alternatives. Alternative Inlet Location 1 is on the shore of the Port Townsend Ship Channel, just north of the west jetty. Alternative Inlet Location 2 is also on the shore of the Ship Channel, but further north (Figure 9). The 2 alternative channels would be 900–1,300 ft long. Both of these alternatives would have essentially the same effect on the physical condition of the lagoon and water levels in general, as they would create a more stable inlet based on analysis for this study. However, the northern alternative (Location 2) would have more direct access to a deeper area of the lagoon, and would likely provide slightly better flushing. The south beach inlet/breach would be filled with sediment derived from creation of a new inlet channel. This would make the south beach continuous and would also relieve the hydrostatic pressure from the lagoon on the south berm.

An analysis of proposed inlet stability was performed by PWA as part of this study (Appendix 2). Given the existing lagoon tidal prism, the equilibrium cross-sectional area was estimated at 76 ft^2. Using the existing channel as a guide, the new channel would need to be approximately 42 ft wide and 3.4 ft deep at MHHW to remain stable in the long-term. A two-stage channel is proposed with a wider “floodplain” above MHHW to lower channel flow rates and reduce scour potential during very high water levels. Rock armoring may be required to the inlet mouth to prevent excessive erosion and mitigate potential impacts to the ship channel.

Construction of one of these two inlet alternatives would require a moderate level of disturbance to the lagoon in the short-term, while providing long-term connectivity to the marine environment. While some excavated sediment could likely be reused on the south beach following rock removal, a large quantity of sediment would either be placed on what is now uplands near the new channel or exported from the site. However, export could likely be avoided to lower the expense of truck or barge export.

Conclusions

Under present conditions the inlet through the south beach is only slightly to intermittently stable. The boat ramp currently acts to create wave refraction on the northeast side that has allowed the inlet to remain open since December 2003. Nonetheless, the inlet has been shoaling in recent years and will likely close due to sediment transport into the lagoon and the gradually reduced tidal prism over time. The No-Action alternative therefore has the lagoon system on a trajectory of gradual in-filling and gradually reduced habitat areas, along with an increased tendency for the inlet to close. In the long-term, the inlet is likely to be open only intermittently. If closure was to occur, this would cause substantial loss of net ecological function for nearshore species. Ecological assessment requires additional work.

If the inlet were left as is but the rock revetment and boatramp were removed to restore the beach and spit, the likelihood of inlet closure increases. The boatramp would no longer trap sediment on the southwest side or produce wave refraction on the northeast side, resulting in increased infilling of the tide channel and accretion of the flood tidal delta.

Under both Alternatives 2 and 3, which would remove the revetment and boat ramp, close the present inlet and create a new inlet to the Port Townsend Ship Channel (Figure 9), the inlet would be more stable and the south beach/spit would be continuous to the west jetty. As this berm was robust and contained a broad supratidal area during pre-ship channel mapping (1850s and 1870s), and the beach receives a relatively large volume of sediment through net shore-drift, the spit would not appear to be under threat of instability or breaching. The spit would function naturally with periodic overwash and would therefore migrate northward somewhat as it has been doing for many decades (Johannessen and Waggoner 2007). While the expense and short-term impacts to the lagoon would be fairly high, a stable inlet would provide greater benefit in terms of physical connectivity between the lagoon and marine environment in this relatively large lagoon and salt marsh system.

Limitations of This Report

This report was prepared for the specific conditions present at the subject property to meet the needs of specific individuals. No one other than the client should apply this report for any purposes other than that originally contemplated without first conferring with the coastal geologist who prepared this report. The findings and recommendations presented in this report were reached based on a brief field visit. The report does not reflect detailed examination of sub-surface conditions present at the site, or drainage system designs, which are not known to exist. It is based on examination of surface features, bank exposures, soils characteristics, beach features, and geologic processes. In addition, conditions may change at the site due to human influences, floods, earthquakes, groundwater regime changes, or other factors.

Thank you for engaging the professional services of Coastal Geologic Services, Inc. If we can be of any additional assistance please contact our office.

References

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Hirschi, R. and T.L. Doty, 2004, Juvenile salmonids use of Little Oak Bay, Jefferson County, WA., Prepared for: U.S. Army Corps of Engineers, Seattle District

Hirschi, R., pers. comm., March 2009.

IPCC (Solomon et al.), 2007. Technical Summary. In Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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List of Figures

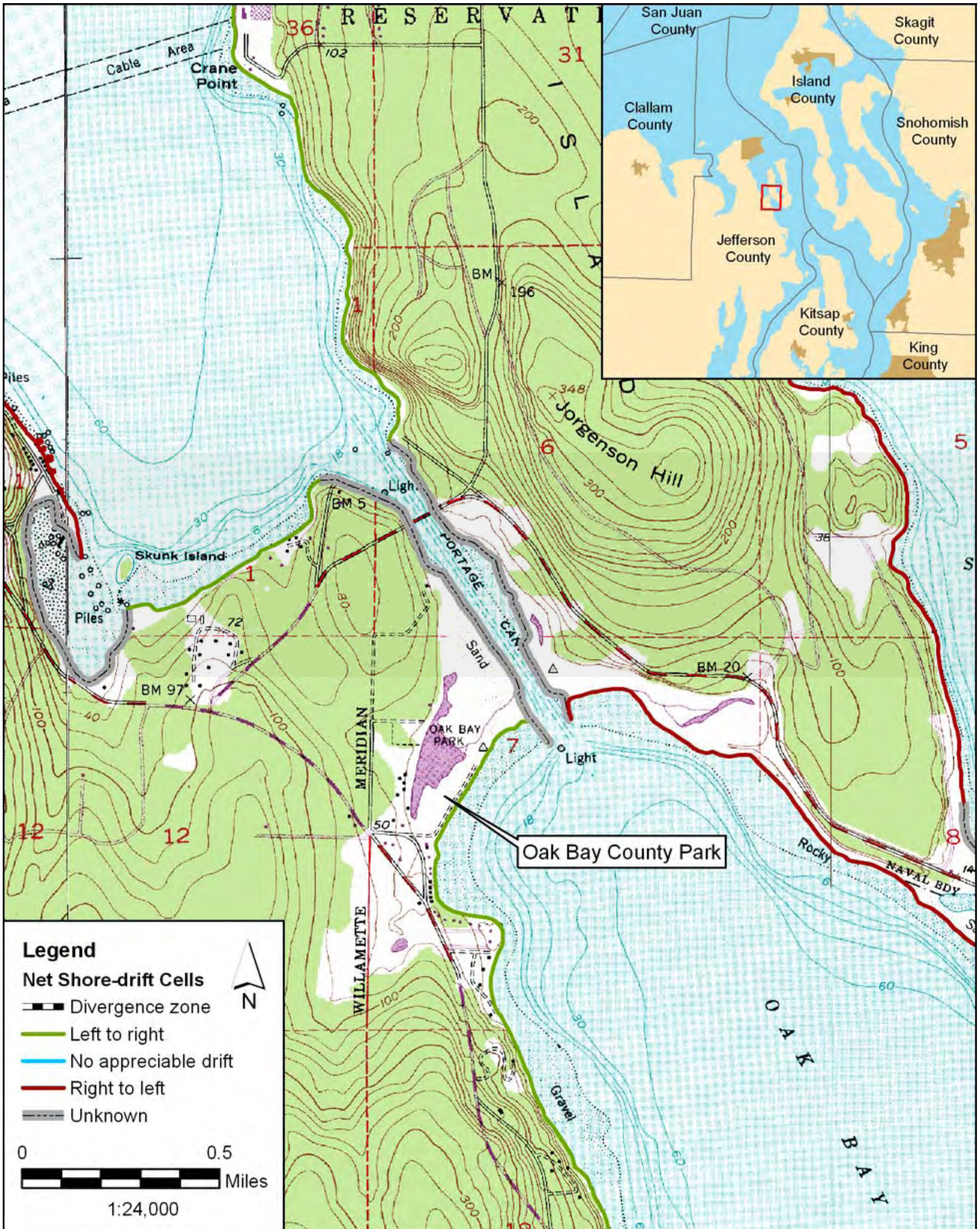

Figure 1. Oak Bay County Park and vicinity showing net shore-drift cells.
Net shore-drift adapted from Keuler (1988)
USGS Nordland quadrangle

Shoreline armoring looking southwest, note angular rock low on the beach at left.

Camping sites (now decommissioned) at the eastern end of the Park spit.

Shoreline armoring looking southwest near the end of the Park.

Shoreline armoring looking northeast, note angular rock low on the beach at right.

Lower end of boat ramp at the Park

Upper end of boat ramp at the Park

Figure 2. Site photographs showing the spit, shoreline armoring, and boat ramp at the park. Top photos taken 5/18/07, middle and bottom taken 3/16/09.


Tidal inlet looking into lagoon at low tide


Tidal inlet looking toward Oak Bay at low tide


Spit on western side of tidal inlet


Sand dune forms on flood delta, likely formed by wave action entering the lagoon at high tide


Northeastern portion of lagoon looking west


Possible location of new inlet discussed in Alternative 4, note low-lying area filled with wood debris.

Figure 3. Site photographs showing the tidal inlet and lagoon, taken 3/16-17/09.

Figure 4. Oblique aerial photo looking southwest at Oak Bay County Park, taken 6/23/2006 for WA DOE.

Figure 5. Oblique aerial photo looking northwest at Little Oak Bay Lagoon, taken 6/23/2006 for WA DOE.

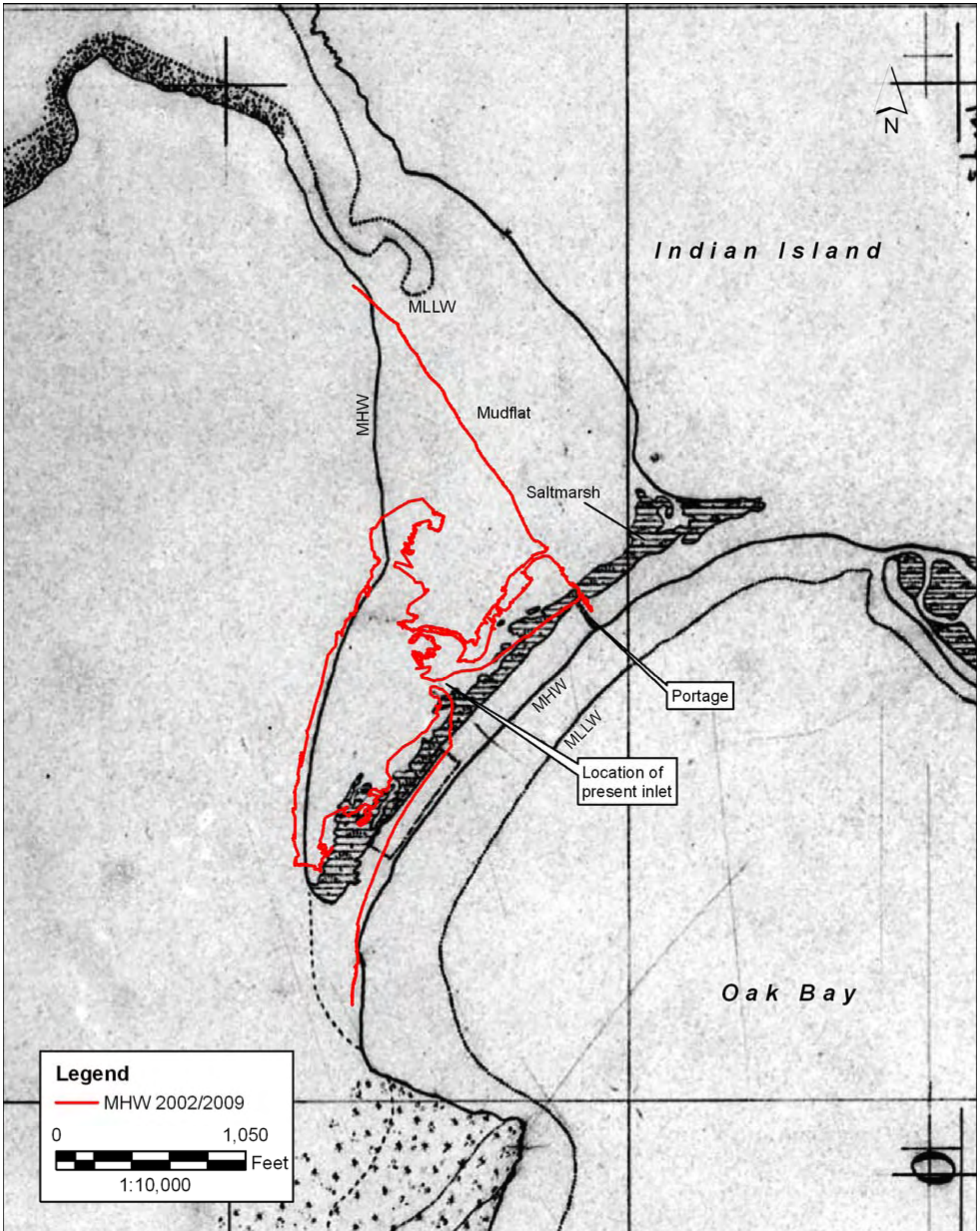

Figure 6. U.S. Coastal and Geodetic Survey T-sheet number 1304 completed in 1872.

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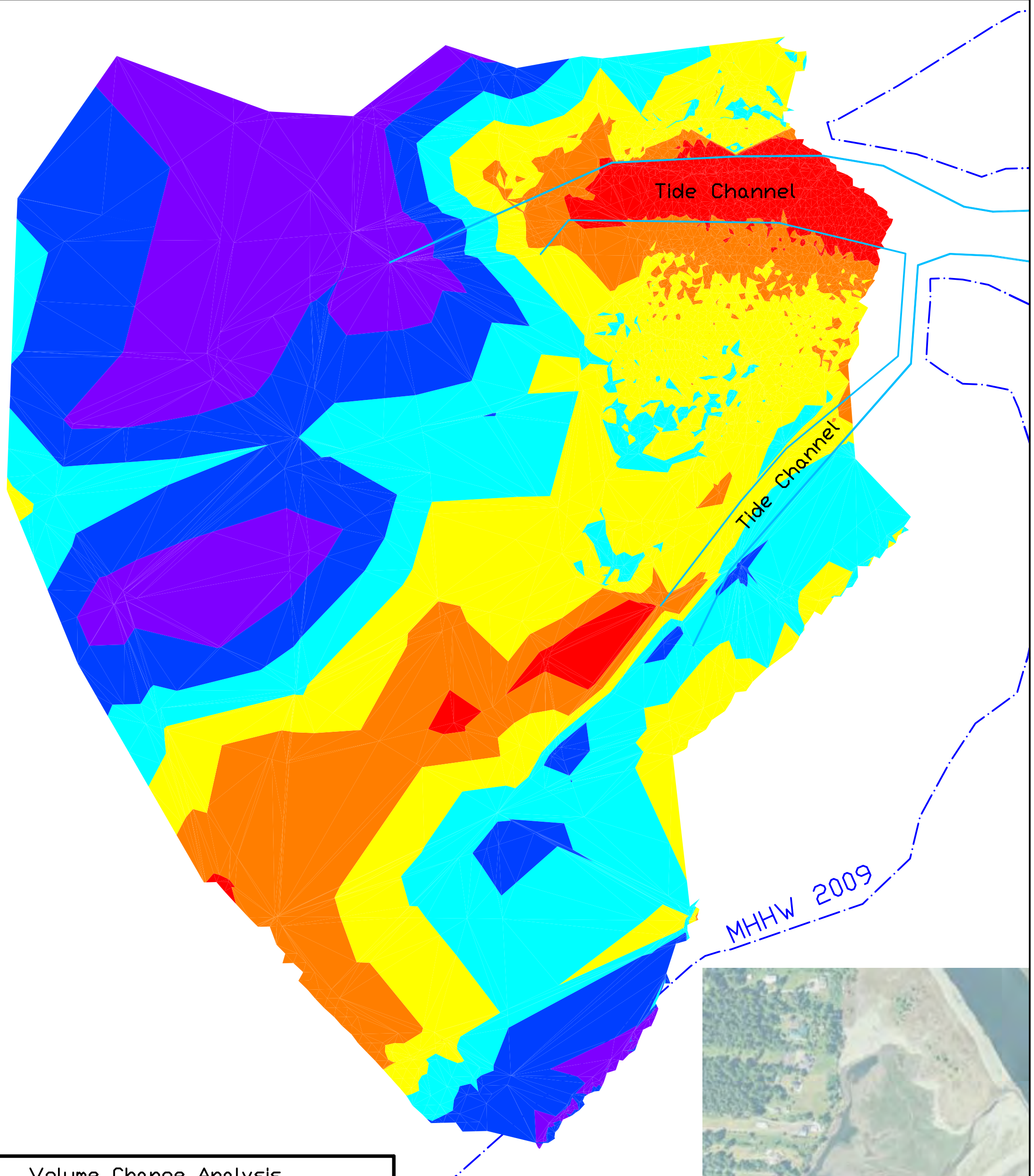

Volume Change Analysis				
Number	Color	Min Elev	Max Elev	Vol (cy)
1	red	-2.61	-1.00	94
2	orange	-1.00	-0.50	266
3	yellow	-0.50	0.00	748
4	cyan	0.00	0.50	1213
5	blue	0.50	1.00	653
6	purple	1.00	1.98	220

Volume Change Results
for area shown:
cut: -1,108 cy
fill: 2,087 cy
net: 978 cy

Figure 7. Tidal inlet volume change between 2002 and 2009 at Oak Bay County Park.
LiDAR data obtained from the Puget Sound LiDAR Consortium

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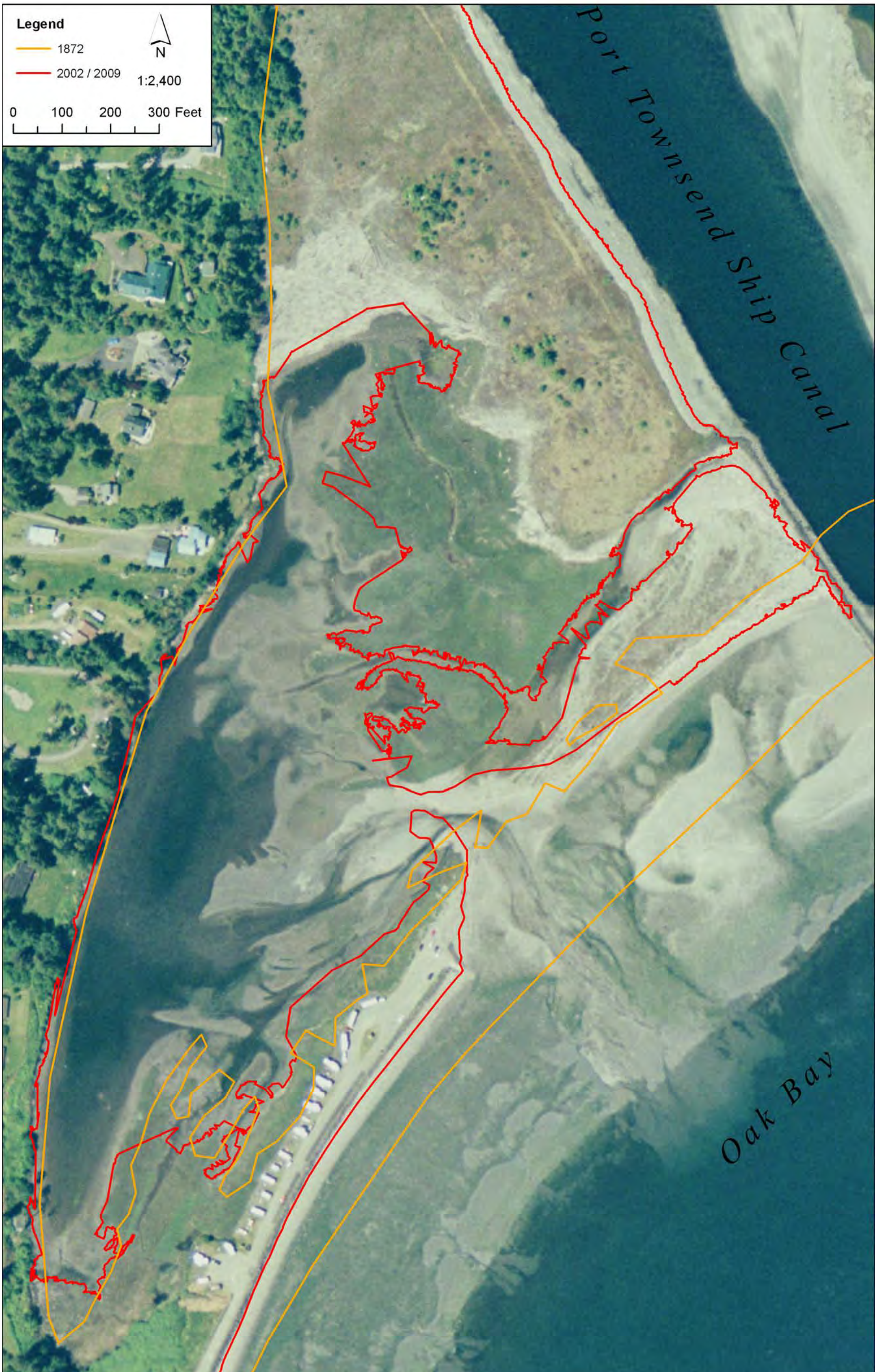

Figure 8. Shore change analysis for the shoreline at Oak Bay County Park 1872-2009.
Background orthophoto from WA DNR (2005). 2009 MHW line derived from combined 2002 PSLC LiDAR and 2009 CGS survey. 1872 MHW derived derived from USCGS T-sheet number 1304 completed 1872.

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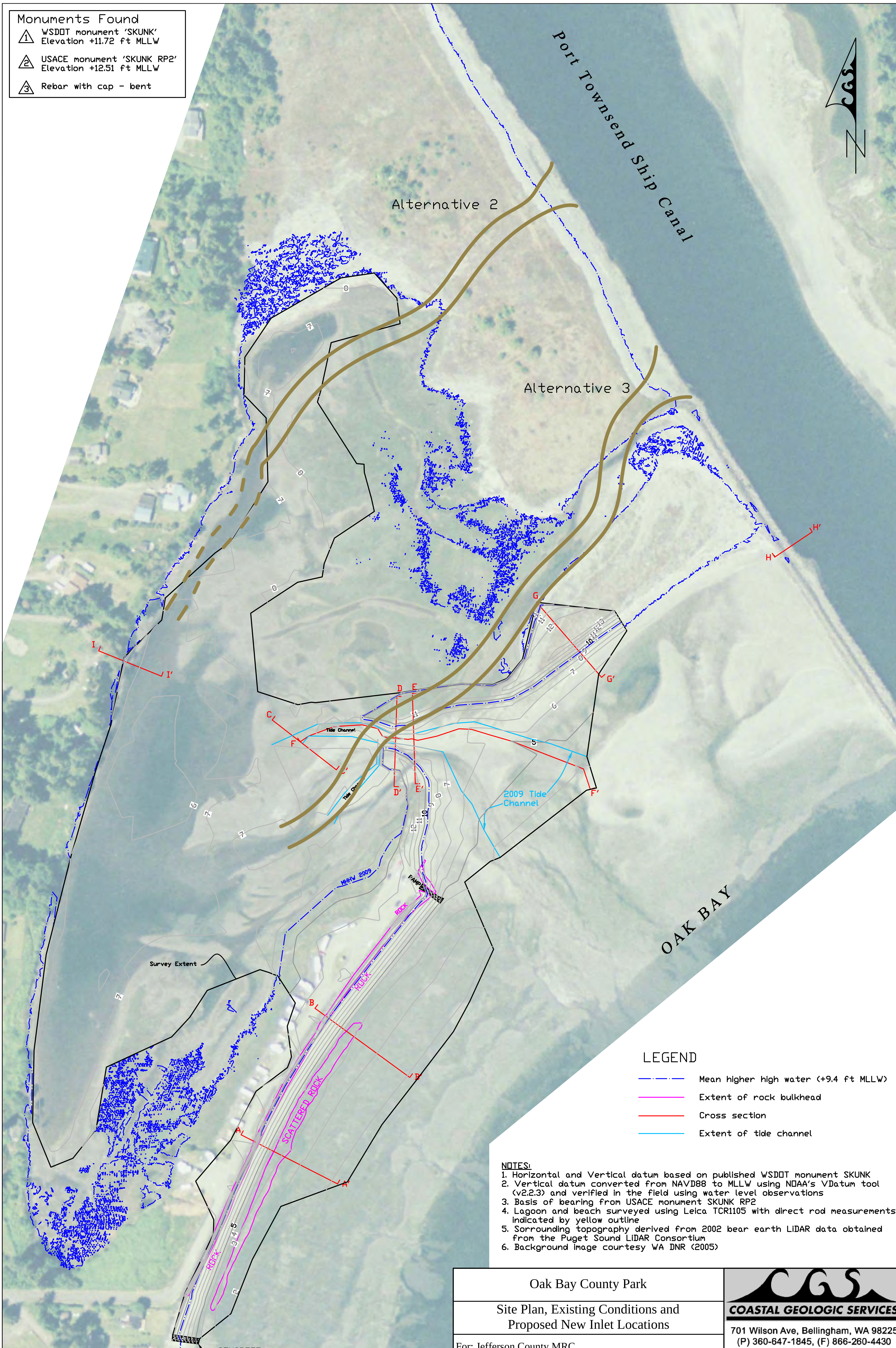

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Site Plan, Existing Conditions and Proposed New Inlet Locations		701 Wilson Ave, Bellingham, WA 98225 (P) 360-647-1845, (F) 866-260-4430 www.coastalgeo.com
For: Jefferson County MRC	~09-008-OBCPMar2009.dwg	
Date surveyed: 3/16/09 Date: 3/25/09		MHHW = +9.4' MLLW; MLLW=0.0'
1"=200'	SITE PLAN	Sheet: 1 of 2

Figure 9. Alternative tidal inlet locations from alternatives 2 and 3.